AFFIDAVIT

On this day, John F. Sanders personally appeared before me and after being duly sworn, deposes and states:

1.   That he is well-qualified as a translator of German to English and is employed as such by Kenyon & Kenyon (One Broadway, New York, New York 10004);

2.   That he has carefully made the attached English language translation from the original German document entitled

Vorrichtung mit mindestens einem Lasersensor und Verfahren zum Betreiben eines Lasersensors
[DEVICE HAVING AT LEAST ONE LASER SENSOR AND A METHOD FOR OPERATING A LASER SENSOR]
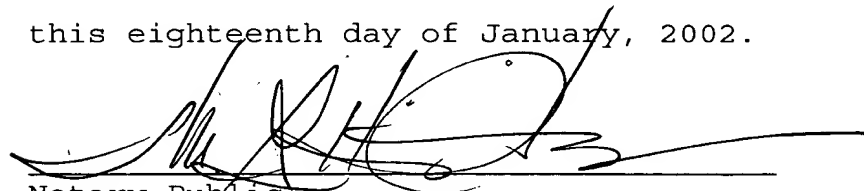
and

3.   That the attached translation is an accurate English version of such original to the best of his knowledge and belief.

JOHN F. SANDERS

Subscribed and Sworn to before me on

this eighteenth day of January, 2002.

Notary Public

DEVICE HAVING AT LEAST ONE LASER SENSOR AND A METHOD FOR OPERATING A LASER SENSOR

The present invention relates to a device for a motor vehicle, having at least one laser sensor, the laser sensor including a device for sweeping, in a scanning area, at least one laser beam that can be emitted by the laser sensor, and including a

5   power supply for the laser sensor. The present invention also relates to a method for operating a laser sensor of a motor vehicle, in a scanning area, using at least one laser beam.

In automotive engineering, information regarding the presence,

10   the distance, and possibly the speed of objects is particularly needed for various control systems. Examples of such control systems or driver-assistance devices include automatic ranging, a pre-crash sensory system that triggers the airbags in a timely manner, lane-changing devices, or

15   park-distance control devices. In this context, various distance sensors based on different physical principles are, in turn, known, such as laser, radar, or ultrasound. Laser and/or radar sensors are almost exclusively used in the application field of automatic ranging sensors, a combination

20   of sensors utilizing the specific advantages of the sensors being especially favorable. In the case of automatic ranging systems or lane-change assistance devices, a fixed, single-point scan of the front traffic space is not sufficient, but rather, a certain sector must at least be

25   scanned in order to reliably detect an object. Such sector-shaped emission is inherent to the radar sensor because of the radiation characteristic of its antenna, whereas, in the case of a laser sensor, this must be done actively by moving the laser or an optical system. In so doing, the laser

30   beam is successively swept across the desired sector and scans it for objects. Since safety distances as long as, for example, 50 m are sometimes necessary, the laser must have an appropriately large range. For this purpose, the laser must

have a correspondingly high intensity, i.e. it must be operated at a high beam power. However, this results in considerable power losses in the laser sensor, which must first of all be supplied by an energy source, and secondly,

5   must be dissipated in the form of heat, using appropriate cooling measures. If passive cooling measures, such as heat sinks, do not suffice in this case, then active cooling systems requiring additional energy must be used.

10   On the other hand, the power output of laser sensors is limited by safety requirements for the benefit of persons in the vicinity of the vehicle, who can be struck by the laser beams and receive an eye injury due to a reflex.

15   Therefore DE 39 03 501 proposes an optical distance-measuring device for vehicles, which includes a semiconductor laser as an emitter for the very short infrared range; on one hand, the emitting capacity of the semiconductor laser being automatically adapted to the environmental conditions,

20   especially visibility, by a signal evaluation unit, and on the other hand, it being adjusted to conform to eye-safety. In the related art, the adjustment of the power output of the system is based on the received signal. This means that the emitting power of the system is a direct function of the power

25   of the received echo signal. If an echo signal is not received from there, because there is no reflecting obstacle in front of the vehicle, then the default emitting power must be selected to be high, in order to cover as large an area as possible in front of the vehicle, and to be able to detect

30   obstacles in this area. Therefore, an object appearing suddenly is struck by an unnecessarily intense scanning beam. A high emitting power must also be selected in the case of poorly reflecting obstacles.

35   In addition, DE 197 07 936 A1 proposes a method for determining a distance of an obstacle to a vehicle, using an optical distance sensor, where the emitting power of the

distance sensor is controlled as a function of the traveling speed, in order to increase eye safety.

The object of the present invention is to provide a device having a scanning laser sensor, and a method for operating such a device, which, on the average, consume less power over time, without losing considerable amounts of information.

The solution of the engineering problem follows from the features of Claims 1 and 8.

The present invention provides for the power output of the laser beam emitted by the laser sensor being variable as a function of the direction of the laser beam.

By varying the power input as a function of the position of the device for sweeping the laser beam, in which case the laser is supplied more power in areas of high relevance than in the less relevant areas, the average power input of the sensor is reduced, so that on one hand, both the power supply itself and a potentially necessary cooling system can be dimensioned to be smaller, and at the same time, the eye safety is increased. The increased service life of the laser sensor can be regarded as a further advantage of the present invention.

Additional advantageous refinements follow from the dependent claims.

An advantageous embodiment provides for the characteristic curve of the laser sensor's beam power being continuously varied.

Another specific embodiment provides for the maximum power of the laser sensor and/or the power characteristic across the scanning area being selected as a function of the vehicle speed, as well.

This has the advantage of the beam power of the laser sensor always being adapted to the actual requirements of the driving situation, and the danger to people being further reduced.

5   Furthermore, it can be provided that the maximum beam power of the laser sensor and/or the power characteristic across the scanning area be selected as a function of a detected object, thereby allowing both the distance of the object and, whether the object is a living thing or an article, to play a role.

10   In particular, the location of the object with respect to the vehicle or the laser sensor is important for the characteristic of the beam power.

The present invention is explained below in detail, using a

15   preferred exemplary embodiment. The one figure shows a scanning area of a laser-scan distance-sensing system.

Represented in Figure 1 is a motor vehicle 1 having a scanning laser sensor 3 positioned in the front area of motor vehicle

20   1, the scanning laser sensor being, for example, a component of an automatic ranging system and a lane-change assistance device. Laser sensor 3 includes a transmitter unit not shown, which emits laser radiation, and a receiving device also not shown, which receives laser radiation reflected by objects or

25   obstacles, and can evaluate it according to propagation time and angle of incidence. In addition, laser sensor 3 includes a device for horizontally sweeping the laser beam across a scanning range 2, which is 180° in the represented example. However, scanning ranges of up to 360° are also conceivable.

30   The device for sweeping the laser beam can either swing the laser as a whole, or is in the form of a suitable optical system. The laser sensor is assigned a power supply, which allows the laser sensor a variable power input that it converts into laser radiation. The larger the beam power made

35   available by the energy supply, the higher the intensity and, thus, the larger the range of laser sensor 3.

In an automatic ranging system, for example, the other motor
vehicles directly in front of motor vehicle 1, which must also
be reliably detected from a longer distance, are of interest,
whereas motor vehicles in adjacent lanes are not as

5   interesting. For example, they are only of interest in the
immediate vicinity of motor vehicle 1, in case the
motor-vehicle driver plans to change lanes, and it must be
checked if motor vehicles are in the desired lane, and if one
can change lanes without risk. On the basis of these

10   preconsiderations, the range of laser sensor 3 can be chosen
to be smaller in the segments, where the scanning area sweeps
over adjacent lanes. This is represented in a discrete form
in Fig. 1, three different segments I, II, and III having been
selected. In this context, Segment I, for example, spans an

15   scanning angle of -30° to 30°, and is used for detecting motor
vehicles traveling directly in front. In this area, laser
sensor 3 is operated at the highest power, and therefore, at
the longest range. Segment II covers motor vehicles, which
are in adjacent lanes, and could possibly move into the lane

20   of the vehicle in question, i.e. should be taken into
consideration during a lane change, this segment II spanning,
for example, a scanning angle of -60° to -30° and 30° to 60°.
Motor vehicles that are nearly adjacent are detected in
segment III, so that a range of 4 to 5 m is completely

25   sufficient. Therefore, the average required power can be
reduced without loss of information. In addition, the optical
power sweeping over a possible, adjacent sidewalk is reduced,
so that the risk of damaging the eyesight of passers-by is
reduced.

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Apart from a stepped reduction in the intensity, the intensity
can also be reduced continuously from the mid-position, i.e.
the intensity function i(α) is a continuous function. In
specific embodiments, where two laser-scan sensors 3 are

35   situated on the right and left, in the front area of motor
vehicle 1, angular distribution i(α) is selected in a

correspondingly different manner, so that the most relevant areas can again be scanned at the highest intensity.

Since the safety distance to be kept is dependent on the speed, the laser is operated, in particular in segment I, at an intensity that increases with the speed. Another option for further variation of the intensity is to pass through the different segments at different scanning speeds. Thus, segment III, for example, can be traversed at a higher scanning speed, in order to further reduce the risk of injuring passers-by.